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Post-Election Risk-Limiting Audit Pilot Program 2011-2013
Semi-Annual Progress Report to the Election Assistance Commission
Reporting Period Close: May 31, 2013

Summary

The California Secretary of State (SOS) received a grant from the federal Election Assistance Commission (EAC) under Section 271 of the federal Help America Vote Act (HAVA) to conduct a two-year post-election audit pilot program during 2011-12 to test new risk-limiting audit models. The research problem for this project is how to conduct risk-limiting audits that include individual contests, multiple contests and cross-jurisdictional contests in small and large elections. The SOS is partnering with the University of California, Berkeley (UC Berkeley) Statistics Professor Philip B. Stark, who developed and conducted initial tests of election audit models in California. The SOS is working with elections officials in up to 20 counties and has so far conducted 10 audits following elections in 2011 and 2012. Grant funds are being used to test and document audit processes and best practices for conducting cost-effective post-election audits using a parallel tally system and the risk-limiting audit methods developed by Professor Stark.

The $230,000 two-year grant from the EAC helps fund:

1) Audits of election results following live elections in up to 20 counties;

2) Detailed analyses of the efficacy of risk-limiting audits and recommendations on modifications needed to make current voting systems auditable; and

3) Creation of auditing tools for elections officials. The pilot program team has developed draft audit rules for selecting the initial sample size and for determining when enough ballots have been audited, methods for ballot-level audits, and user-friendly web-based tools and procedures for conducting and reporting on risk-limiting audits. (A preliminary version is available at statistics.berkeley.edu/~stark/Vote/auditTools.htm)

Risk-limiting post-election audits are audits based on modern statistical principles. The number of ballots initially reviewed in a risk-limiting audit varies based on the margin of victory. The audit escalates – potentially to a full hand count of every ballot cast – if significant differences between the hand tally and the voting system tally are found. Risk-limiting audits are efficient when conducted at the "ballot level," meaning individual ballots (rather than entire precincts) from the voting jurisdiction are subject to the random draw and the audit. Risk-limiting audits generally involve hand counting a few individual ballots from across an entire voting jurisdiction, whereas the 1% manual tally that California law requires county elections officials to conduct following each election generally involves significantly more ballots but only from specific areas of a voting jurisdiction.

The audit team's goals are to develop standards, procedures and tools for conducting post-election risk-limiting audits at the ballot level in order to:

1) Help California and other states develop new, more robust and effective election auditing laws,

2) Inform the design of next generation voting systems,

3) Provide election auditing best practices and procedures that can be used by many jurisdictions in the U.S. using a broad variety of voting systems; and

4) Build public confidence that if there are errors in election results, those errors will be caught and corrected.

Progress

During this phase of the project the following progress was made:

1) In January 2013, the SOS received a 12-month no-cost extension of the project to allow the California Post-Election Risk-Limiting Audit Pilot Project to be completed December 31, 2013.

2) In January 2013, the project advisory panel met and planned several steps for the project team to complete during 2013, the final year of the project.

3) The project team facilitated a one-day collaboration session between Yolo County and the team of University of California researchers (which developed the audit software, but is not funded under this grant) to improve the audit software to make it more user-friendly for county elections staff who may use the software to audit elections in the future.

4) A large multi-contest audit in Marin County – which was started but not completed in the summer of 2012 – was successfully completed.

Counties

Twenty counties originally volunteered to participate in the pilot program. Thus far, audits have been completed in 11 California counties following live elections held during 2011-2012. Eight of the audits were conducted following small local elections held in 2011 and two audits were conducted in small counties, Madera and Napa, following the June 2012 Statewide Presidential Primary Election.

One multi-contest audit, the Marin County audit, was started in July 2012 and had to be postponed due to significant delays in ballot processing caused by the software developed for the audit project. The Marin County audit was successfully completed in February 2013 (see attached report from Marin County).

Two other multi-contest audits, the Santa Cruz County and Yolo County audits, which were started in July 2012 and postponed for the similar reasons, will be completed in the second half of 2013.

The fourth multi-contest audit attempted in July 2012, the Orange County audit, which was also postponed due to software problems, cannot be completed because an election recount occurred following the June 2012 election. As discussed below, because of the limits of voting systems in use today, in order to do a ballot-level audit the county must conduct a parallel scan and tally of all ballots, and the ballots must be kept in the order in which they are scanned. The recount left Orange County's ballots out of order.

Below is a chart showing the status in each participating county.

County	Election	Audit
Alameda	Nov. 8, 2011	Dec. 5, 2011
Alpine	Nov. 6, 2012	Cancelled
Colusa	Nov. 6, 2012	Cancelled
El Dorado	Nov. 6, 2012	Cancelled
Humboldt	Nov. 8, 2011	Dec. 16, 2011
Madera	June 5, 2012	Sept. 20, 2012
Marin	June 5, 2012	Completed in Feb. 2013
Merced	Nov. 8, 2011	Dec. 12, 2011
Monterey	May 3, 2011	May 6, 2011
Napa	June 5, 2012	July 20, 2012
Orange	Mar. 8, 2011	Mar. 14, 2011
Orange	June 5, 2012	Postponed mid-audit. Terminated due to recount.
Sacramento	Nov. 6, 2012	Cancelled
San Luis Obispo	Aug. 30, 2011	Sept. 12, 2011
Santa Cruz	June 5, 2012	Postponed mid-audit. Scheduled for July 2013.
Stanislaus	Nov. 8, 2011	Dec. 2, 2011
Sutter	Nov. 6, 2012	Cancelled
Ventura	Nov. 8, 2011	Nov. 29, 2011
Yolo	June 5, 2012	Postponed mid-audit. Scheduled for completion in summer 2013

Yuba	Nov. 6, 2012	Cancelled

University of California

University of California Berkeley Professor Philip Stark (Stark) is the lead researcher.

Advisory Panel

In January 2013, the advisory panel met and discussed progress on the project and plans for the one year remaining on the project. The panel recommended:

1) Completion of the unfinished audits from 2012 to the extent possible;

2) Approaching counties with cross-jurisdictional special elections in 2013 about conducting a pilot audit;

3) Creating a working group of local elections officials to develop a set of uniform ballot accounting procedures for California counties;

4) Coordinating efforts with the UC Berkeley team of researchers, which developed the OpenCount software used in this pilot project to facilitate user testing by county election staff, so the software can be brought to production; and

5) Developing a set of business requirements for future voting systems that will ensure future voting systems adopted by jurisdictions will have the functionality needed to allow for efficient ballot-level post election risk-limiting audits.

The team is currently working to implement these recommendations.

The project advisory panel is comprised of the following experts, advocates, and community activists in the field of election auditing and reform:

Dean Logan
Registrar-Recorder/County Clerk, Los Angeles County

Pam Smith
President, Verified Voting

Joseph Lorenzo Hall
Postdoctoral Research Fellow, New York University Department of Media, Culture and Communication

Hovav Shacham
Assistant Professor, University of California, San Diego, Department of Computer Science and Engineering

Mark Halvorson
Director and Founder, Citizens for Election Integrity Minnesota

Susannah Goodman
Director, Common Cause National Campaign for Election Reform

Margaret MacAlpine
Research Associate, SafelyLocked, LLC

Conducting Ballot-Level Risk-Limiting Audits Using a Parallel Scan and Tally

For most election audits, the results of a hand tally are compared to the results recorded by the voting system. For California's 1% manual tally, elections officials hand tally entire precincts of ballots and compare those hand tally totals to the precinct-level machine-tallied totals generated by the voting system.

For risk-limiting audits to be efficient, they must be conducted at the individual ballot level, not the precinct level. A ballot-level audit compares the result tallied by the voting system for a given ballot to a hand tally of the same ballot. To conduct a risk-limiting audit at the ballot level, two things are necessary: 1) the voting system must have a cast vote record (CVR) for each ballot. A CVR is a line of data that shows how the votes on a given ballot were actually tallied by the voting system; and 2) elections officials must be able to match a CVR to the corresponding physical ballot, which requires keeping ballots and CVRs in the order in which they are scanned.

Early in the pilot program, the pilot project team conducted a series of conference calls with voting system vendors to determine the capabilities of existing voting systems. Through these calls and discussions with participating counties, the team determined that none of the voting systems in use in California is capable of exporting CVRs that can be associated with corresponding physical ballots.

For this reason, the team conducts the audits for this pilot program by means of a parallel scan and tally of the votes. A parallel scan and tally is a second tally of the ballots, using commercial-off-the-shelf (COTS) scanners and open source tally software developed during spring and summer 2011 for the pilot program.

County elections officials scan the ballots using a COTS scanner and either mark the ballots or keep the ballots in order to permit each physical ballot to be paired with its scanned ballot image. This method allows auditing the interpretation of individual ballots rather than auditing vote subtotals for entire precincts. Making individual ballots auditable – i.e., creating auditable "batches" of one ballot each – brings very significant

efficiency, as described above. The hand counting work load for a ballot level audit can be smaller than the workload of a precinct level audit by a factor of 1,000 or more. Presuming the parallel tally for each audit shows the same winner(s) as the official voting system, the audit can confirm the official results *transitively* (i.e., if A = B, and B is correct, then A is correct).

Web-Based Tools and Instructions

The pilot program team, led by Stark, developed a set of web-based tools (statistics.berkeley.edu/~stark/Vote/auditTools.htm) and instructions for elections officials. The tools explain how the audits work and show the math behind the tools, so elections officials and the public can understand risk-limiting audits. These tools are continually being refined and improved as a part of the pilot program.

Audits Completed Between December 1, 2012, and May 31, 2013

In February 2013, Marin County completed its risk-limiting audit of the June 2012 election. Marin made preparations for its audit in July 2012 but had to postpone due to delays in ballot processing caused by the audit software and the county's need to prepare for the November 2012 Statewide General Election. Marin County used the web-based audit tools and completed its multi-contest audit autonomously, without on-site assistance from Stark. Marin County's report and cost comparison sheet are attached.

The cost of the post canvass risk-limiting audits continues to be more expensive than California's 1% manual tally requirement because of the high cost of scanning ballots a second time for purposes of the audit. When next generation voting systems are adopted which can capture and produce ballot-level results, the ballot scanning step of the audit can be eliminated, and the audits will become a much less expensive undertaking.

MARIN COUNTY ELECTIONS DEPARTMENT
REPORT ON POST CANVASS RISK LIMITING AUDIT
June 5, 2012 Presidential Primary Election

BACKGROUND

The post canvass risk limiting audit in Marin County of ballots cast in the June 5, 2012 Presidential Primary Election was part of a pilot project on risk limiting audits conducted with the Secretary of State's Office and UC Berkeley professors Philip Stark, Professor of Statistics and David Wagner, Professor of Computer Science.

AUDIT PROCESS

After the June 5th election was certified, the Marin County Elections Department scanned 29,121 ballots from Supervisor Districts 2 and 4 with a Department-owned Fujitsu 5950 scanner. The scanner made an optical image of each side of each ballot and imprinted a number one side of each ballot. Supervisor Districts 2 and 4 were chosen because each districts had a district wide race for County Supervisor contained wholly within it.

The Election Department transmitted the ballot images to Professor David Wagner to prepare a transparency count of the votes on the scanned ballots. A comparison of the winners on the county's Statement of Votes for the districts showed that they were the same as the winners on the transparency count. The remainder of the audit was put on hold until after the November 6, 2012 General Election.

The audit of ballots took place on February 14, 2013. The Elections Office posted a Notice of the audit on its website and front door and sent a copy of the Notice to its Election Advisory Committee. On Feb. 14 the department set up the room for the audit with one laptop computer and printer not connected to the Internet, one desktop computer and printer connected to the Internet to access the audit tools page on the UC Berkeley Dept. of Statistics website, and two projectors and screens for the public to view the ballot images.

The comparison of ballots started at 9:30 a.m. There was one public observer present. The Audit Tools report showed that the number of ballots to be audited was 54, based on the number of votes cast in each race and the margin of victory of the candidates. The observer rolled eight 10-sided dice to get a seed number which was then entered into the audit tools to produce the random numbers of the 54 ballots to be compared. Two Elections Dept. staff pulled the ballots in the audit sample from sealed containers while one staff member printed out the results of the transparency count for each ballot. The Observer and Elections Dept. staff compared each ballot with the results from the transparency scan and found that all votes matched. The audit ended at 12:00 p.m.

Cost comparison between risk limiting audit and 1% manual tally

Cost of risk limiting audit	
Cost of scanning ballots	$4,637.54
Cost of transparency audit	$1,447.57
Total Cost	$6,082.11

Cost of 1% audit	$5,154.56

County of Marin
Cost Comparison of Conducting Risk-Limiting Audit vs. 1% Manual Tally
Presidential Primary, June 5, 2012

Risk-Limiting Audit:						1% Tally:					
	Staff involved	Hours/Mins	Hourly Rate		Total	vs.		Staff involved	Hours/Mins	Hourly Rate		Total
Establishing audit procedures	EG, TA	2.00	(see Risk worksheet)	$	162.69							
Audit set up (public notice, scheduling, equipment rental):	EG, TA, CW	10.50	(see Risk worksheet)	$	549.53		Audit set-up:	EG,DB	0.50	(see 1% worksheet)	$	74.71
Exporting voting system results/creating ballot manifest for audit:	TA	19.90	(see Risk worksheet)	$	1,097.66		Printing reports:	TA	0.50	(see 1% worksheet)	$	27.58
Ballot Scanning (for parallel tally):	TA,CW,4EH	148.60	(see Risk worksheet)	$	4,562.54							
Sample size calculation and random draw:	TA,EG,MB	1.50	(see Risk worksheet)	$	123.44		Random draw:	EG,DB	1.00	(see 1% worksheet)	$	74.71
Finding particular ballots in the audit sample:	MB,CW	4.00	(see Risk worksheet)	$	242.24		Finding ballots:	2 EH	8.00	(see 1% worksheet)	$	228.37
Analysis and reporting:	EG,TA	3.00	(see Risk worksheet)	$	244.04		1% tally:	8 EH, DB	202.50	(see 1% worksheet)	$	5,073.92
Totals		189.50		$	6,982.12		Totals		212.50		$	5,479.29